

REVIEW ARTICLE

Raspberry Pi Traffic Density Observation Associate Controlling System

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ABSTRACT

This paper explains a Raspberry Pi controlled Traffic Density monitoring system. Raspberry Pi is a single board computer which can be effectively used for multi-functionalities. Here is the one of the ways of using this for multiple purposes. Here, we propose a technique which is used for traffic surveillance purpose where the traffic is continuously monitored and viewed through a live streaming. In addition to this, it is used to detect the traffic density and send the traffic information to the traveler. Here we are monitoring the traffic, based upon the density of the vehicles. If the density is low on a particular side, the time period for that side will be reduced automatically; if the density is medium, the time period for that side will remain the same; and, if the density is high, the time period will automatically increase, compared to the normal density. Here, the time period means time given to the green light to glow to that particular side. Using IR sensors, the density of vehicles of each side is identified. Traffic for each side can be monitored by live streaming. A USB camera interface to Pi3 is used for this purpose. By rotating camera 360 degrees, one step 90 degrees In Raspberry pi3 are a great choice for traffic sensing, because it is equipped with a variety of sensors such as Wi-Fi, L293D, IR sensors, DC gear motor, Camera and Microphone. These sensors can be exploited to collect traffic data. This traffic report is updated periodically and displayed on the screens installed at the public places.

Keywords: Raspberry Pi; Traffic Density; Live Streaming; Traffic Surveillance; IR sensors; l293D Driver; DC gear motor.

1. INTRODUCTION

India is a large country and is second most populous country in the world with a fast-growing economy. Life at present confronts different kinds of problems, one of which is the increase in the number of vehicle users. This creates chaos and traffic control problems. The growth of Infrastructure and the number of vehicles in India is neither equal nor proportionate; due to excess population, the increase in the number of vehicles is much faster than the growth in the infrastructure [1]. The capacity of the roads and interaction along the roads (cross-roads/junctions) are not capable to handle this number of vehicles [2]. At present, the number of vehicles is increasing day by day, causing traffic congestion on the roads which leads indiscipline, disorder

and occurrence of accidents. It needs to be reduced as per the vehicles which are available on the road lanes.

The traffic surveillance process plays a very crucial role in finding who caused the traffic obstruction. Traffic surveillance can be done by using Raspberry Pi which is more effective than the conventional methods. The installed Raspberry Pi system gives live streaming of the monitored traffic in a particular area. This method can be adopted by considering the other advantages that accompany the use of Raspberry Pi. Along with live streaming, this system allows the camera to detect the traffic density in the surrounding places. This adds an additional advantage to the existing system by doing another task simultaneously, without interrupting the main task.

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It gathers the information about statistical distribution of traffic over the geographical area which is under surveillance and stores it in a database. To let the users (travellers) know the information about traffic density, display screens placed will be those public places and there will be a website which is specially designed to show the traffic compactness in a particular place. Thus, people will be aware of the traffic in advance and change their path to reach their destination in time.

2. RASPBERRY Pi

Raspberry Pi is a credit-card-sized single-board computer as shown in Figure (1). This board is cost effective when compared to an actual computer, as shown in Figure 1; it uses power rating of 5V, 700mA and weighs not more than 50g. It comes in 3 variants of Model 1 A+, Model 1 B+ and Model 2 B. It is also available as Compute Module Development Kit, which is a handy device for industrial applications and has more flexibility [3-5].



Figure 1 Raspberry Pi 1 B+ Board

It typically operates on ARM11 processor at 700MHz frequency with 512MB RAM. It runs the operating systems like Noobs, Rapsbain etc. which are installed on the SD card. It has 1 Camera connector to interface with the camera module. Accessories like Keyboard, Mouse and USB Wi-Fi dongle can be connected through 4 USB 2.0 ports. Ethernet connectivity through RJ45 port, 3.5mm Audio Port with low noise power supply can be linked up. It can be connected to LCD/LED monitor, Televisions and Projectors to display the information through HDMI port. The sensors, switches and the of LEDs are done by 40 GPIO pins. As all these are embedded on a single board, Raspberry Pi is not just limited to single use; it can be of wide use according to the application. As a whole, Raspberry Pi is used as a multi-purpose single board chip. It is used for Traffic surveillance

[6], counting up traffic density using Computer Vision and display it on screens.

3. SYSTEM DESIGN

The main aim of the system is to estimate the traffic density and traffic surveillance. This is done by using Computer Vision [7]. Computer Vision is the transformation of data from a still or video camera either into a decision or a new representation [8]. Open CV is an open source computer vision library. The system consists of Raspberry Pi, Camera and Advertising screens. As already mentioned, Raspberry Pi is a mini computer; and, it is installed with Open CV module [9]. Camera is interfaced with the Raspberry Pi through USB port. Advertising screen is interfaced through HDMI cable of Raspberry Pi (as shown in Figure 2).

After completing all the installations, the system is mounted in the best place that fits the purpose and is powered on. The camera monitors the vehicles travelling on the road continuously and counts each vehicle, using a piece of code written in python [10]. This count is given to database along with the camera id. The details will be stored in the database. The traffic density of a particular road will be shown on the screen by retrieving the data from the database. The effect of density is shown in different colours like red for higher density or green for low density traffic.

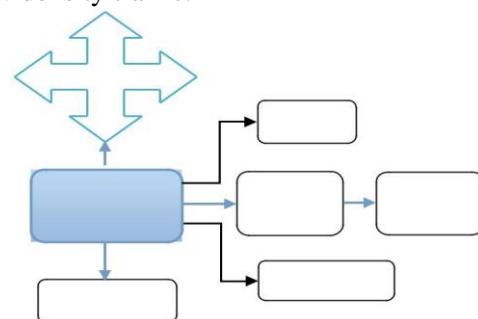


Figure 2 System Design

The camera installed continuously monitors the vehicles; this monitoring can be recorded and given live streaming by the use of Raspberry Pi, so that if any violations of the normal rules occur, it can be easily noticed and the person who violated the rules can be punished accordingly. Thus, by recording the vehicle motion and broadcasting it live to the control room serves the purpose of traffic surveillance.

The digital screen which is used for displaying the results of traffic density is also used for advertising purposes. Screen can be partitioned so that some part displays the traffic density and the other parts forgive advertisements; this also helps in making profit.

4. ALGORITHM

The System Design Open CV [7] runs much faster than similar programs written in Mat Lab. (If it is not fast enough, it can be made faster by optimizing the source code). For example, one might write a small program to detect people's smiles in a sequence of video frames. In Mat Lab, typically 3-4 frames are analysed per second. In the Open CV, at least 30fps are obtained, resulting in real-time detection. Open CV being an open source is the other major advantage and Mat Lab is licensed and expensive. In this system, Open CV is used with python coding for image processing like object identification, segmentation and recognition in a simple and effective manner as shown in Figure (3).

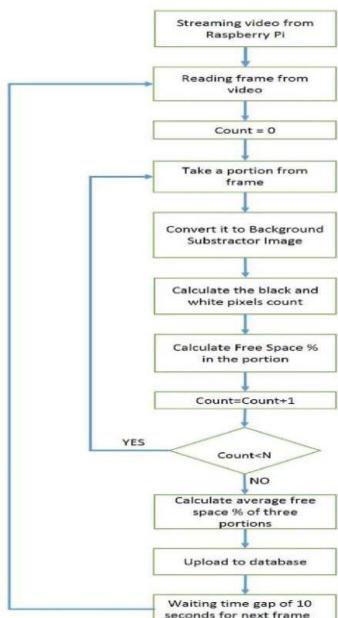


Figure 3 Flowchart

Algorithm: (Traffic Surveillance) In Raspberry Pi, a python program is written for monitoring the traffic and image processing technique, called background subtraction [8], using Open CV [9].

The automotive traffic control System functions in the following Seven Stages:

1. Image Acquisition

2. Image Pre-Processing
3. Morphological Processing
4. Blob Analysis
5. Count Density (No of Vehicles)
6. Find Vehicle Emergency or Not
7. Send Signal

1. Image Acquisition: Image of the vehicle is captured using the video camera and is transferred to the image processing system in Open CV [12].
2. Pre-processing: The Acquired image is enhanced using the contrast and brightness enhancement techniques [13].
3. Greyscale Conversion: It involves conversion of colour image into a gray image [14]. The method is based on different colour transform. According to the R, G, B value in the image, it calculates the value of gray and obtains the gray image at the same time [15].
4. Image Binarization: Greyscale image is converted into black and white images i.e. binary images using thresholding operation.
5. Traffic Density Calculation: By applying Morphological filtering and Blob analysis on the binary image, the number of vehicles will be counted and compared with the Traffic density threshold.
6. Identify Ambulance: By using Binary image, Morphological filtering, and Blob analysis, the ambulance will be detected.
7. Send ambulance signal to the Raspberry pi: The identified ambulance is sent to Raspberry pi through serial port.

Flow of the Proposed System:

- A) Camera: Continuously records the traffic scene.
- B) Read Image: Takes one frame per second from the video using image processing.
- C) Image Subtraction: In the system, the background image without vehicles (Initial Condition) is already saved and the current image of the traffic is subtracted from the background image.
- D) Convert Image to Binary:
 - a. Creates black and white images.
 - b. Vehicle=White. Background= Black
- E) Morphological Processing:
 - a. It Performs Image Filtering.
 - b. Uses 2 processes:

Open: Removal of White dots other than the vehicles.

Close: Removal of Black dots other than the background.

F) Blob Analysis:

- Checks the current density of the vehicle.
- Checks tags on the vehicle, if any.

G) Find Vehicle Emergency or not:

- Verifies if the emergency vehicle is present.
- If it is present, then generates green signal.
- If not, then counts the number of vehicles and generates lanes.
- Greater density lane = green signal and other lane = Red.

5. RESULTS

The frame demonstrates the traffic densities on the road lanes as shown in the Figures 4, 5 and 6; and, the background subtraction technique is used as shown in Figures 7, 8 and 9. The averages of the frames captured are calculated and free space exhibiting traffic statistical distribution is located.

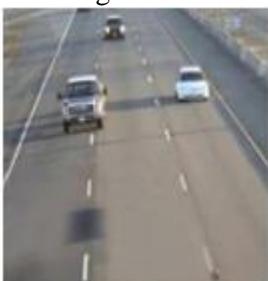


Figure 4 Recorded video frames low traffic



Figure 7 Background of subtracted frames low traffic



Figure 5 Recorded video with medium traffic



Figure 8 Background frames subtracted frames with medium traffic

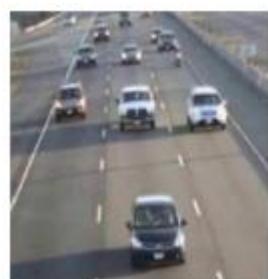


Figure 6 Recorded video frames traffic

Figure 9 Background with subtracted frames with high Traffic

The traffic distribution is plotted onto Google Maps [10,11] showing the colour indications as shown in Figures 10, 11 and 12, representing green colour with less traffic, violet colour with average traffic and red colour with heavy traffic.



Figure 10 Output map displaying traffic density with colour green: Low traffic

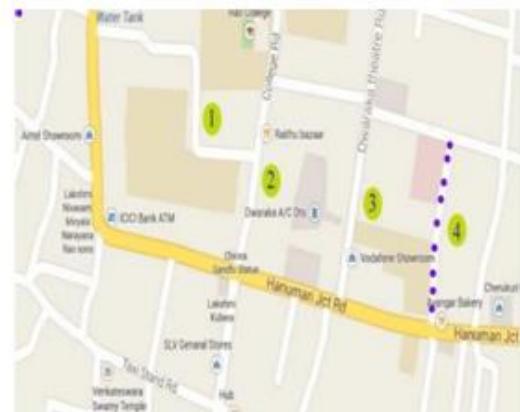


Figure 11 Output map displaying traffic density with colour Violet: medium traffic

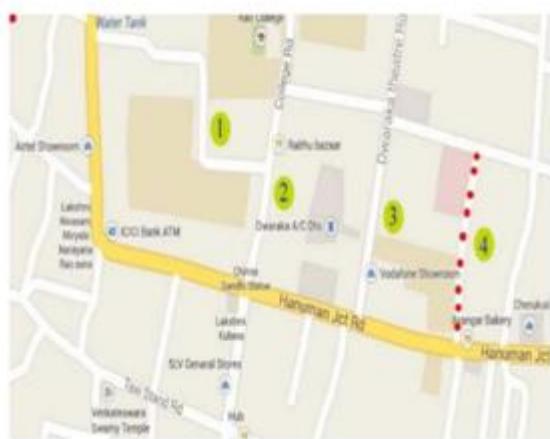


Figure 12 Output map displaying traffic density with colour red High traffic

6. APPLICATIONS

This whole process can be done without using Raspberry Pi. But what is needed is an input image to the Python code that is written to count the number of vehicles present in that image. From that image the density of the traffic is found out and displayed on the screens. Similarly, the Open CV is used for live streaming the continuously monitored and recorded video. And the advertisements can also be done through the screens. Here, the notable point is: Raspberry Pi is replaced by a personal computer [16].

This can be further implemented to get the traffic updates through mobile notifications by accessing their GPS; and using Google's Location Service, it can propose to the people the best possible alternative routes to their destinations depending upon the traffic intensity. It can also be used to switch the traffic signals depending upon the traffic congestion. It can also be extended to notify the people towards the shortest path.

7. CONCLUSION

This proposed system reduces the possibilities of traffic jams, caused by high red light delays and provides the clearance to the emergency vehicles to an extent and very successfully. Here, the system is designed with the purpose of clearing the traffic in accordance with priority. In this system, the traffic density is found out using Morphological filtering and Blob analysis.

The road with the highest priority is cleared first. The proposed system also assigns importance

to the ambulance. If any ambulance is waiting at a signal, then the particular lane is given higher priority and the traffic in that lane is cleared. Emergency vehicle is detected by using the image processing system. Whenever the emergency vehicle enters the lane, the Morphological filtering and Blob analysis detect the vehicle using the camera image and send it to Raspberry pi. Raspberry pi gives high priority to the lane with the emergency vehicle and clears that particular lane.

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